The research cruise POS 531 is the first research cruise within the MARUM Excellence Cluster 'The Ocean Floor – Earth's Uncharted Interface'. The scientific party consists of scientists from MARUM, Max Planck Institute for Marine Microbiology, University of Bremen, Institute of Chemistry and Biology of the Marine Environment, Carl von Ossietsky Universität Oldenburg, and Alfred Wegener Institute for Polar and Marine Research.

The research aim of POS 531 is to investigate carbon and nitrogen cycling in sandy shelf sediments off the coast of Morocco in order to better understand their influence on pelagic primary production and lateral transport to the open ocean. This will allow us to better understand the role of primary production in sandy shelf regions for open ocean carbon sequestration.

The transfer of organic matter from the surface ocean to the ocean floor is a key regulator of atmospheric CO_2, the exclusive food source for life in vast areas in the deep sea, and the main pathway for the long-term storage of carbon in the sediments. However, the mechanisms of transformation, degradation, and preservation of organic matter within the water column and at the seafloor are hardly understood. Algal blooms form dissolved and particulate organic matter, which together with (bio)minerals aggregate into settling particles that shuttle carbon and other elements into the deep ocean. Along its vertical path, this flux is rapidly attenuated by microbial activity, making the oceans a "gigantic heterotrophic digester" that is directly tied to atmospheric carbon dioxide levels. Our understanding of chemical transformation processes and the origin and age of settling particles is insufficient due to the inherent chemical complexity of organic matter in the ocean and the poorly constrained transport mechanisms of organic matter and (bio)minerals through the water column and at the sea floor. The magnitude of export depends on how the particle flux is transformed as it falls. To understand the functioning of the ocean's biology and chemistry, we need to understand what controls both the horizontal and vertical transport of material through the water column.

RV Poseidon left the port of Las Palmas, Gran Canaria, Spain, on 18th January 2019 at 09:00 on schedule and started the voyage in a SW direction towards our study area off the coast of Morocco. Sunday morning the 20th January we started our station work at the off-shore long-term mooring site 'CB' at 17:00. We deployed one CTD Rosette and two In Situ Camera profiles to identify the different water masses and the vertical distribution of settling aggregates through the water column. We further recorded water currents and backscattering with an ADCP (Acoustic Doppler Current Profiler), which was provided and equipped on RV Poseidon by colleagues from GEOMAR. By this point of the cruise we were still awaiting the permissions to enter Moroccan waters from

the authorities in Morocco. However, since the CB station is in international waters, this did not affect our scientific work.

Monday morning (21.01.2019) at 09:00, we continued our work at station CB and deployed our first drifting array DF-20. The drifting array consisted of four cylindrical sediment traps at each of three depths; 100, 200 and 400 m. One of the four cylinders at each depth was filled with a viscous gel to preserve the shape and structure of the fragile settling particles. Hereafter we investigated the particle dynamics through the water column by deployments of three CTD Rosettes, one secchi disk, three In Situ Camera profiles, several hand nets for zooplankton sampling, and one Marine Snow Catcher. Station work ended at 23:00.

The Marine Snow Catcher collects small in situ formed organic aggregates. We measure the small scale activities within those aggregates on board and can directly measure the rate at which bacteria and other microorganisms degrade the organic and respire it back to CO_2. In parallel we determine the settling velocity of each of the collected aggregates and can thereby determine how fast the aggregate sink in relation to how fast the microorganisms can respire organic matter, i.e. turn it back into CO_2. If the respiration occur in the surface ocean, the CO2 will immediately be exchanged with the atmosphere, however, if the majority of this respiration occur at depths below 1000 m then the CO2 will stored in the ocean for hundreds of years.

From Monday morning at 09:00 (21.01.2019) to Tuesday at 9:00 we conducted the first 24 hour diel cycle experiment measuring algal production and zooplankton at the CB station to compare light driven the production rhythm of microalgae with the feeding rhythm of zooplankton. We took samples every hour through the ship inlet pump at a depth of about 5 m. In addition we obtained water from the CTD at 10 AM, 4 PM, 4 AM from five different depths. The water samples were filtered to obtain particulate organic matter for carbon and nitrogen analysis. The filtered seawater was extracted with affinity chromatography to measure dissolved energy molecules such as carbohydrates that are an important food source for bacterio-plankton. In addition to these water samples we casted a zooplankton net every hour to collect crustaceans and other organisms feeding on microalgae. In parallel we conducted on deck incubation experiments where we incubated microalgae with 13C to obtain assimilation rates during the light and dissimilation rates during the dark phase.

Tuesday (22.01.2019) at 04:00 we continued the station work with two CTD Rosettes, two In Situ Cameras, one Secchi Disk, and the recovery of the drifting array (DF-20). We received the permissions from the Moroccan authorities at 08:00 and could therefore plan our next station on the Moroccan shelf and after we had finished our work at station CB at 13:00, we steamed towards the shallow shelf station (30 m depth).

Wednesday (23.01.2019) at 16:00 we arrived at the shallow shelf station where we would investigate the interactions between sediment and water column processes. This was done by deployments of several Van Veen Grabs, one In Situ Camera, one CTD Rosette, one Marine Snow Catcher, several Sediment Multi-Corers, several zooplankton hand nets, and the 24 hours deployment of the LanceALot lander. The LanceALot was equipped with scanners that recorded the seafloor typography, pigment composition, and oxygen distribution. We also deployed a Benthic-Boundary-Layer Sampler (BBL Sampler), however, the burn-wire release mechanisms did not work. Since we had calm weather the sampling of the bottom water could also be done with the CTD Rosette instead of the BBL Sampler. The station work ended at 21:00.

Sediment collected with the Van der Veen Grab was packed into flow through reactors and subsequently oxygen consumption rates were measured and incubations were carried out using stable isotope tracers to determine nitrogen cycling rates. This data will be combined with in-situ data collected using the benthic lander to determine areal fluxes of oxygen consumption and nitrogen loss. The MUC cores were used to determine the release of FDOM from the sediment and the flow velocity needed to resuspend the sediment and microphytobenthos. When combined this provides valuable information on the fate of material reaching the sandy seafloor.

Thursday (24.01.2019) we started with Van Veen Grabs at 06:30 to sample the sediment in the dark in order to prepare for incubations for benthic primary production. Hereafter we deployed two CTD Rosettes, one In Situ Camera, a Secchi Disk, and a Marine Snow Catcher before we recovered the LanceALot. At 15:00 we ended the work at the shallow station and steamed towards our slope station.

Friday (25.01.2019) we started the work at the slope station at 09:00 where we deployed the next drifting array (DF-21). Hereafter we deployed three CTD Rosettes, three In Situ Cameras, one Secchi Disk, several zooplankton hand nets, and one Marine Snow Catcher. The station work ended at 23:00.

From Friday morning at 09:00 (25.01.2019) to Saturday at 9:00 we conducted the second 24 hour diel cycle experiment measuring algal production and zooplankton at the 600 m slope station. We took samples every hour through the ship inlet pump. In addition we obtained water from the CTD at 10 AM, 4 PM, 4 AM from five different depths. The water samples were filtered to obtain particulate organic matter for carbon and nitrogen analysis. The filtered seawater was extracted with affinity chromatography. In addition to these water samples we casted the zooplankton net every hour. In parallel we conducted on deck incubation experiments where we incubated microalgae with 13C.

Saturday (26.01.2019) we started our station work at 04:00 with one CTD Rosettes, hereafter, we deployed two In Situ Cameras and recovered the drifting array. The

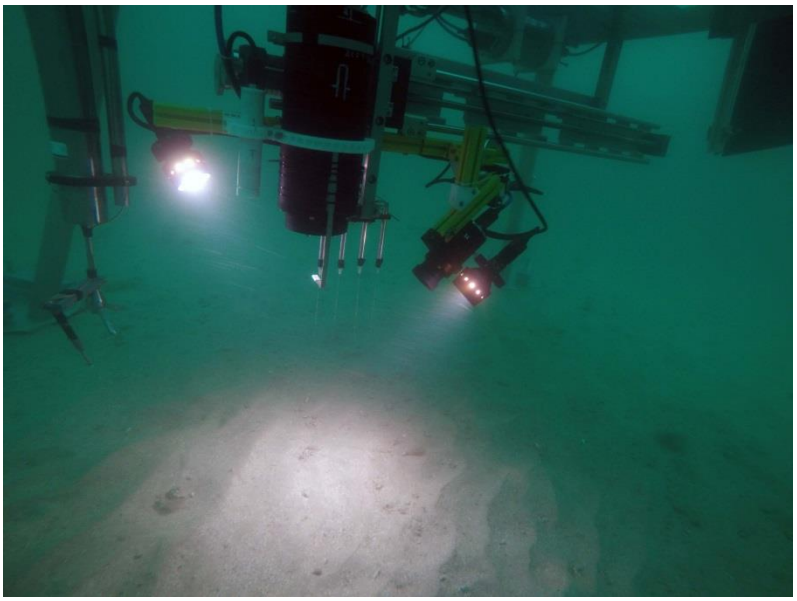
station work at the slope station ended at 10:30. Hereafter we started our transect work from the slope station to the 30 m shelf station. This was in total 6 transect stations with a CTD Rosette and an In Situ Camera deployed at each of them. The lmADCP was also running during both the long-term stations and the transect. We ended the transect work at 22:00.

Sunday (27.01.2019) at 08:00 we started the work at the 60 m shelf station. We first deployed two CTD Rosettes and 10 Van Veen Grabs, to both collect water for incubations and to survey the sediment to test if it was sandy before we deployed the LanceALot lander. At 10:30 we deployed the LanceALot and thereafter we stayed near the lander to study the biogeochemical processes in both the water column and the sediment. This was done by deploying four In Situ Cameras, one Secchi Disk, one Marine Snow Catcher, four Sediment Multi-Corers, and several zooplankton hand nets. The station work ended at 23:00.

At the 60 m shelf station the incubations for benthic processes were repeated. The sandy seafloor at this station was much less permeable than the previous shelf station, and initial experiments suggested that oxygen consumption rates were substantially higher.

From Sunday(27.01.2019) morning at 09:00 to Monday at 9:00 we conducted the third 24 hour diel cycle experiment measuring algal production and zooplankton at the CB Station. We took samples every hour through the ship inlet pump at a depth of about 5 m. In addition we obtained water from the CTD at 10AM, 4PM, 4AM from five different depth. The water samples were filtered to obtain particulate organic matter for carbon and nitrogen analysis. The filtered seawater was extracted with affinity chromatography to measure dissolved energy molecules. In addition to these water samples we casted a zooplankton net at 10 AM, 4 PM, 9 PM and 10 PM to collect crustaceans and other organisms feeding on microalgae. In parallel we conducted on deck incubation experiments where we incubated microalgae with 13C.

Monday (28.01.2019) at 04:00 we continued the work at the 60 m shelf station and deployed two CTD Rosettes, one In Situ Camera, and one Van Veen Grab before we recovered the LanceALot at 10:30. Hereafter we started our transect stations towards the off-shore long-term monitoring station CBi, which is also going to be our final research station during the POS 531 cruise.



LanceALot during scanning of the seafloor with a hyper-spectral camera to map the pigment distribution on the sediment surface.

Viele Grüße von der Crew und dem Forschungsteam.

Dr. Morten Iversen